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नहरों में रिसाव क्षति का मापन — रीति संहिता

भाग 1 जल संचयन पद्धति

(पहला पुनरीक्षण)

Indian Standard

MEASUREMENT OF SEEPAGE LOSSES FROM CANALS — CODE OF PRACTICE

PART 1 PONDING METHOD

(First Revision)

UDC 626·82 : 624·131·64 : 532·57 : 006·76

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Irrigation Canals and Canal Linings Sectional Committee had been approved by the River Valley Division Council.

Irrigation project design, operation and maintenance, and canal lining research and development require accurate and economical measurement of seepage rates. The possible benefits from canal lining are saving in water, elimination of waterlogging, and reduction in maintenance cost. Hence, correct assessment of seepage losses from unlined canals and field observations are the best means to make a realistic assessment.

The loss of water by seepage from unlined canals in India generally varies from 0·3 to 7·0 $m^3/S/10^6 m^2$ depending on the permeability of soil through which the canal passes, location of water tables, distance of drainage, bed width, side slope and water depth inside the canal. In addition, flow velocity, soil and water temperature, atmospheric pressure and stratification of the underlying soil also affect the seepage rate.

The seepage losses from unlined canals can be calculated by analytical methods or determined by direct measurement. The analytical calculations of seepage losses based on coefficient of hydraulic conductivity of soil and the boundary conditions of the flow system, are of particular value for the canals which are in the planning stage. The methods of direct measurement of seepage are applicable to the existing canals.

Currently accepted methods for direct measurement of seepage losses from existing canals are ponding, inflow-outflow and seepage meter methods. In adddition, there are special methods such as tracer technique, electrical logging or resistivity measurement, piezometric surveys and remote sensing. The ponding and inflow-outflow methods are applicable regardless of canal or soil conditions. The seepage meter cannot be used where the canal has a rocky bottom or heavy weed growth. The tracer technique is best suited to canals in homogeneous and isotropic formations.

This standard has been prepared in three parts, Part 1 dealing with the ponding method, Part 2 dealing with inflow–outflow methods and Part 3 dealing with the seepage meter method. This standard (Part 1) was published in the year 1980. The revision has been done so to update its contents based on further studies conducted in U.P. Irrigation Research Institute, Roorkee. The principal modifications made are in respect to (a) Selection of site and length of pond, (b) use of LDPE films, (c) giving additional details in the procedure with figures.

Indian Standard

MEASUREMENT OF SEEPAGE LOSSES FROM CANALS — CODE OF PRACTICE

PART 1 PONDING METHOD

(First Revision)

1 SCOPE

This Standard deals with measurement of seepage losses in open canals by ponding method.

2 REFERENCES

The Indian Standards listed below are necessary adjuncts to this standard:

IS No.	*Title*
4080 : 1967	Specification for vertical staff gauges
6939 : 1992	Methods of determination of evaporation from reservoirs (*first revision*)

3 PONDING METHOD

3.1 For determining seepage losses by ponding method, a reach of the channel is isolated by constructing temporary bunds or by bulk heads on existing control structures.

3.2 The method can be employed even on large canals depending upon the availability of the material and equipment for the construction of bunds and water for filling the pond. The method is applicable to canal with discharge capacity of about 15) cumecs. The seepage losses from the ponded reach are computed from the rate of loss of water from the pond (after adjustment of evaporation losses) and the dimensions of wetted area of the pond. The rate of the loss of water from the pond is obtained by measuring the rate of drop of the water level inside the pond. A modification of the method consists of adding water to the pond to maintain a constant water surface elevation. The seepage losses in this case are computed from the volume of water added to the pond and the wetted perimeter of the pond.

The observations can be made with reasonable accuracy with this method and as such the result may be taken as a good indication of the average loss from the seepage of the canal. The measurements obtained with it are generally used as the standard of comparison for seepage measurements obtained otherwise. This method is particularly useful in measuring small seepage losses. It can be applied to smaller reaches of a canal.

4 SELECTION OF TEST SITE

4.1 Several factors govern the selection of a test site. The site selected for measurement of seepage by ponding method should comply with the following requirements:

a) A curved reach of the canal should be avoided;

b) The reach should be so selected that the nature of the material in the canal bed has small variation within the ponded reach;

c) The ponded reach should be so selected so as to avoid inflow, outflow and structures which are a source of leakage as it may be difficult to evaluate the rate of loss through them;

d) The test reach should have an approach road and service road along it so that necessary equipment can be transported;

e) When the pond is to be formed with earthen bunds, availability of materials for the bund may be an important factor in selecting the site;

f) Site should be free from heavy scouring or silting;

g) The reach selected should preferably be downstream of a regulator. This should facilitate the filling of test reach by gravity flow after construction of bund on the downstream end; and

h) Length of the pond should be large enough so that the area of the end bunds is a small percentage of the total wetted area. The length of the pond should depend upon the bed width, water depth of canal and availability of suitable site. Based on these variables and practical considerations the length of pond should be approximated as suggested below:

Bed Width/Depth of Water B/D	*Suggested Length of Pond in Metres*
Up to 5	40 times of (B/D) ratio
5 to 20	35 times of (B/D) ratio
Exceeding 20	30 times of (B/D) ratio

5 CONSTRUCTING THE PONDED SECTION

5.1 Three methods or combinations thereof may be used to create the ponded section; which of these is used depends primarily on the size of the canal.

5.1.1 The first method comprises construction of temporary barrier or bunds built of canvas held in place by a timber at the top and dirt thrown along the edge on the cross-section. Such a dam is normally restricted to small canals where the water table is less than about 0·6 m above canal bed. A heavy weight canvas treated with water proofing will usually function with a minimum of leakage. Heavy plastic sheets may also be used.

5.1.2 In the second method, the pond may be constructed with earthen bunds at each end. The material is usually pushed into place with the help of a dozer or some other device. If the canal is dry, during bund construction the dozer can compact the soil by repeated trips back and forth across shallow lifts. When the canal contains water, care should be taken not to attempt compaction until the movement of water past the bund has been stopped and the base width is sufficient to resist unrestricted spreading of the fill from the weight of the dozer. Natural soil moisture is usually sufficient to attain reasonable compaction. The bund should be made impervious by laying low density polyethylene (LDPE) film. The thickness of LDPE film should depend on the initial ponded water depth as given below:

Water Depth to be Ponded	*Thickness of LDPE Film (Micron)*	*Water Front Slope of Bund*
Up to 1 m	100	1·5 : 1
1 m to 2 m	150	2 : 1
Exceeding 2 m	200	2 : 1

5.1.3 Soil cover of 15 cm to 30 cm should be provided over LDPE film to protect the film from damage.

5.1.4 A typical set up for observing seepage losses by ponding method is given in Fig. 1 and 2.

5.1.5 In the third method, existing structures such as regulators may be used to pond water. Planks may be used and placed in the stoplog slots. Canvas may be draped over the ponded side to cover open joints and to prevent leakage around the ends of the planks. The canvas is held in place along the edges and

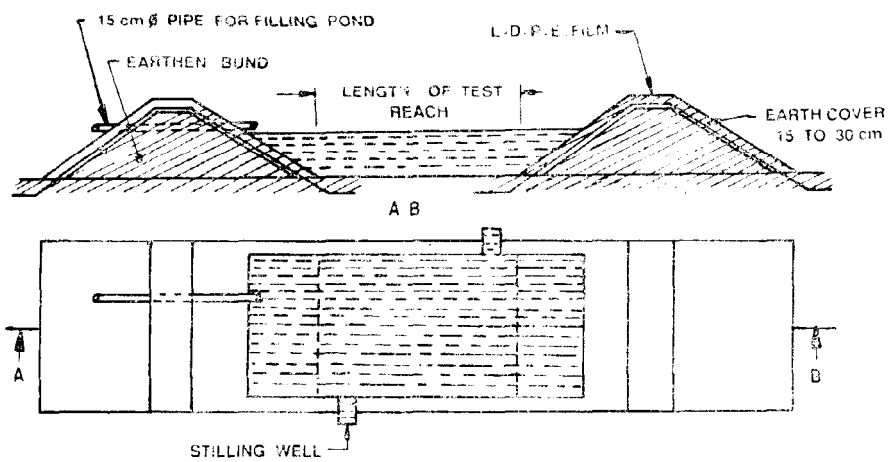

FIG. 1 TYPICAL PONDING METHOD SETUP FOR SEEPAGE LOSSES

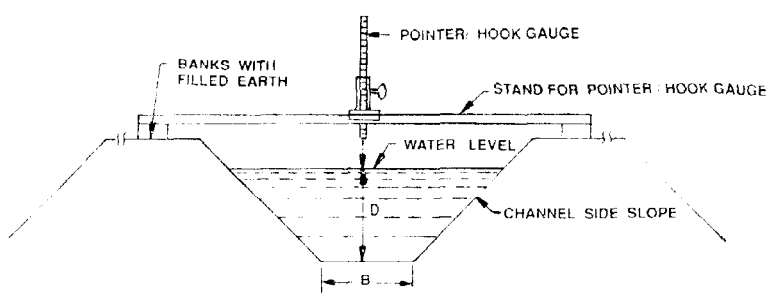

FIG. 2 TYPICAL CROSS SECTION OF PONDING METHOD SETUP FOR SMALL CHANNELS

bottom by soil packed against it. LDPE film may be substituted for canvas to cover the joints.

6 EQUIPMENT

6.1 The equipment required to conduct ponding tests is simple to operate but adequate precautions have to be taken when installing it.

6.1.1 The equipment consists of two hooks/pointers and two staff gauges and in some locations an evaporation pan. A hook and staff gauge should be paired for use at the upstream and downstream ends of the pond. The hook gauge is a laboratory type gauge and can be read up to 0·0001 m with the aid of the vernier. The staff gauge is a standard enamelled gauge frequently used on irrigation projects to indicate the water depth and scaled to 0·001 m (*see*) IS 4080 : 1967).

6.1.2 The gauges should be installed on vertical uprights that have been firmly positioned near the edge of the pond. Each gauge should be connected to survey bench marks on the canal so that depths in the pond can be correlated with design depth.

6.1.3 Two sets of hook and staff gauges should be used. The staff gauge reading should serve as a rough check of the hook gauge reading and should the hook gauge be accidentally disturbed, the staff gauge should be read until resurvey establishes a new reference on the hook.

6.1.4 During windstorms, the water surface of the pond may not be horizontal throughout the length of the pond. Therefore, average water surface elevations should be determined by having gauge readings at each end. A stilling well should be provided around the hook to minimize the error in observations due to disturbances in the water surface.

6.1.5 *Evaporation Pan*

The evaporation losses from the pond surface may be significant as compared to seepage losses from lined canals. In order to apply corrections due to evaporation, an evaporation pan should be used for measuring the evaporation rate during the ponding tests. To determine evaporation, a reference may be made to IS 6939 : 1992.

7 PROCEDURE

7.1 Gravity flow or pumping may be used to fill the test pond depending on the conditions that prevail at the site and the size of the canal. The filled up water should be free from high silt content.

7.2 With the pond filled and all gauges operative. measurement of the rate of drop in the water surface may be started. The observations of the tests should be recorded in the proforma as given in Annex A. The time of each reading should be recorded to the nearest minute.

7.3 For smaller channels up to a bed width of 2 m the arrangement shown in Fig. 2 should be adopted and for wider channels stilling wells located at extreme ends of pond should be constructed to observe water levels at various intervals.

7.4 Before starting the observations for seepage losses, initial reading of the pointer gauge should be taken on each stilling well simultaneously and recorded.

7.5 The rate of fall of the water surface within a few hours after the initial readings of the gauge should provide an indication of loss rate. If the pond seems to have a high loss rate, reading should be recorded at an interval varying from 1 to 4 hours, for a pond showing a very slow rate of drop, less frequent readings may be taken. Seepage losses may be computed from the observations recorded after the steady state condition has been achieved.

7.6 Observations should be avoided during rainfall or else rain-gauge should be installed.

8 ANALYSIS OF RESULTS

8.1 Survey notes should be used to compute and tabulate the water surface width and wetted perimeter for various water surface elevations of canal as shown in Annexes B and C. The cross-section of the canal should be plotted accurately to obtain wetted perimeters and water surface width, correct up to 0·01 m. The increments of elevations for compuations of water surface widths and wetted perimeter depend upon the size of the canal, depth in the pond and the range of the test depths. Each column under a particular elevation is averaged for all stations to obtain the representative characteristics for the entire pond.

8.2 The information contained in Annexes A, B and C is sufficient for computation of loss rates. To facilitate these computations a statement as shown in Annex D should be prepared.

8.3 Seepage rate ($m^3/S/10^6\ m^2$) under steady state condition is obtained by the formula:

$$\text{Seepage rate } [m^3/S/10^6\ m^2] = \frac{\text{Total volume lost } (m^3) \times 10^6}{3\,600 \times \text{average wetted perimeter } (m) \times \text{Total time in hours} \times \text{length of pond } (m)}$$

9 LIMITATIONS

9.1 Ponding method has the following

limitations and disadvantages:

a) The method interrupts the normal working of the canal;

b) The construction of temporary barriers or bunds to form the pool and their removal afterwards will involve expense. The method should, therefore, be employed only when the importance of the test warrents the expenditure;

c) A large quantity of water is needed for filling the pool initially and subsequent replenishment during the test may involve difficulties;

d) Although the ponding method gives accurate figures for the total seepage losses from the pool, it does not show variation in rates for different parts of the pool;

e) The seepage losses for the pool may be slightly different from those taking place from the canal with flowing water. However, the difference would be quite inconsequential;

f) In the computation of seepage losses, it has been assumed that the effect of variable head is negligible; and

g) The losses worked out are the losses in the total experimental reach for the water table, temperature and humidity conditions in the reach at the time of the experiment.

10 ADVANTAGES

The method is relatively more accurate and dependable.

ANNEX A

(*Clause* 7.2)

SEEPAGE LOSS DATA – PONDING METHOD

Canal.....Hook gauge One end.....other end.....

Distributaries.....Chainage.....Staff gauge One end .....

Other end.....Observer.....

Date	Time	Hook Gauges		Staff Gauges		Temperature	
		One End	Other End	One End	Other End	Air	Water

ANNEX B

(*Clauses* 8.1 *and* 8.2)

TABLE OF WATER SURFACE WIDTHS

Name of canal..... Pond No. .....

Chainage.....

Chainage KM	Water Surface Width for Various Elevations		
	El...	El	El.....
Average			

ANNEX C

(*Clauses* 8.1 *and* 8.2)

TABLE OF WETTED PERIMETERS

Name of canal..... Pond No. .....

Chainage KM	Wetted Perimeter for Various Elevations			
	El.....	El.....	El.....	El.....
Average				

ANNEX D

(*Clause* 8.2)

STATEMENT SHOWING THE DETAILS FOR COMPUTING SEEPAGE LOSSES BY PONDING METHOD

Date	Time	Accumulated Time (h)	Water Surface Elevation	Evaporation Correction (m)	Rainfall Correction (m)	Corrected Water Surface Elevation (m)	Water Surface Width (m)	Volume Lost (m^3)	Wetted Perimeter (m)	Average Wetted Perimeter (m)	Seepage Rate cumec/ m^2
1	2	3	4	5	6	7	8	9	10	11	12

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